EFFECTIVENESS OF MOTOR IMAGERY VERSUS MIRROR THERAPY TO IMPROVE UPPER LIMB TRAINING IN STROKE SUBJECTS – A COMPARATIVE STUDY

DISSERTATION

Submitted for the partial fulfillment of the requirement for the degree of

MASTER OF PHYSIOTHERAPY (MPT)

(Elective - MPT Neuro)

May – 2018

By

Regn. No: 271620261

Submitted to:

THE TAMILNADU DR.M.G.R MEDICAL UNIVERSITY

CHENNAI – 600032.

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Date:

Place: Chennai

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CERTIFICATE

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…… **……**

Internal Examiner **External Examiner**

Place:

Date:

DECLARATION BY THE CANDIDATE

I hereby declare that the Dissertation entitled "**EFFECTIVENESS OF MOTOR IMAGERY VERSUS MIRROR THERAPY TO IMPROVE UPPER LIMB TRAINING IN STROKE SUBJECTS – A COMPARATIVE STUDY**" was done by me for the partial fulfillment of the requirement of Master of Physiotherapy degree. The dissertation had been done under the direct supervision and guidance of my Guide at **Mohamed Sathak A.J college of Physiotherapy**, Chennai, and submitted the same during the year May 2018 to **The Tamilnadu Dr. M.G.R Medical University.**

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Place: Chennai

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Signature of the Candidate

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ABSTRACT

Background

Stroke rehabilitation helps to restore lost function and reintegrates the stroke survivors into the society. Based on mirror neuron system, mental practice (MP) does cognitive rehearsal of activities that involves same cortical changes as physical practice in stroke survivors.

Objective

To determine the comparative efficacy of a mental practice (MP) intervention versus a mirror therapy (MT) intervention on upper limb motor function after stroke.

Methodology

A thirty acute stroke subjects were assigned to the mental practice (MP; n-15) or to the mirror therapy (MT; n-15) group. Subjects were assessed before and after 7 weeks of intervention using Action Research Arm Test (ARAT). MP group was administered functional activity based visual motor imagery training and MT group was administered functional activity based mirror therapy training. Both groups had five tasks of real life rehearsal strategies and each session consisted of 60 minutes, 3 days in a week.

Results

After the intervention, means of ARAT using an ‘independent t-test’ showed subjects in the mental practice (MP) group were significantly higher than those of subjects in the mirror therapy (MT) group. There is a statistically significant difference in grasp, gross, pinch, grip and total score between the groups.

Conclusion

Mental practice is a promising adjuvant therapy to physiotherapy practice with minimal direct supervision and minimal expense. It’s feasible to self-administer in virtually any environment with no specialized equipment.

Keywords: Mental practice, Motor imagery, Mirror therapy, Stroke rehabilitation, Plasticity

INTRODUCTION

In India, stroke incidence is elevating than western countries. Stroke causes life time disability among adults and it is the important burden parameter. In India, there were 795.57 per 100,000 person-years disability-adjusted life years (DALYs) lost because of stroke (Shyamal Kumar et al 2016). The prevalence rate is 84-262/100,000 in rural and 334-424/100,000 in urban India (Jeyaraj Durai et al 2013).

Stroke Rehabilitation is the long term and it is a costly area of care in developing countries like India where it requires a team effort including a patient and caregivers. Novel self-management interventions in stroke rehabilitation like mirror therapy and mental practice have shown to be useful adjunct exercise therapies (Stroke 2016).

The basis of human social organization is action understanding. We can call this as imitation learning. The observation of physical actions done by others activates the motor cortex, without any overt motor activity is called as mirror-neuron system. Based on mirror-neuron system the conception of novel intervention mirror therapy (MT) and motor imagery (MI) get evolved. Several studies confirmed the mirror neurons physiological functions in the human brain which has action perception and action execution mechanism.

Motor imagery (MI) or Mental practice (MP) is a technique where the movement is imagined and mentally rehearsed without voluntary movement. This practice induces neural plasticity which is the key to restore movements especially the upper limb function.

Many studies have proved the benefits of MI and MP with sub-acute stroke patients. Studies using a mirror therapy aimed to get mirror reflection facilitates paretic upper limb functions in real-world scenarios. Mental practice or Motor imagery is found to enhance the cortical level reorganization similar to that of physical exercise.

Need for the study:

As the mirror therapy and mental practice are novel techniques, experimental research on short-term treatment and protocol is required for evidence-based intervention.

Aim of the study:

To evaluate the effectiveness of motor imagery intervention versus mirror therapy intervention in motor recovery after stroke.

Objective of the study:

To determine the comparative efficacy of a mental practice (MP) intervention versus a mirror therapy (MT) intervention on upper limb motor function after stroke.

Hypothesis:

Null hypothesis (H_0) - There is no significant difference in the improvement of upper limb function between the groups having mental practice (MP) and mirror therapy (MT).

Alternate hypothesis (H_a) - There is a significant difference in the improvement of upper limb function between the groups having mental practice (MP) and mirror therapy (MT).

REVIEW OF LITERATURE

Literature review on stroke

1. **Pandian et al 2013 study,** says that the double burden of non-communicable diseases are in rise in developing countries like India. Good rehabilitation set-up for stroke rehabilitation is available in private hospitals in urban areas which is insufficient to tackle the need of large populated country. An organized effort to meet up the growing epidemic is the need of an hour.

2. **Banerjee et al 2016 study,** says that In India, the the burden of illness of stroke is much higher high income countries. Though prevention is the best option to control the stroke incidence, intervention studies are the important need for this kind of brain disorders.

3. **Winstein et al 2016 study,** says that a health care reformation particularly in terms of stroke rehabilitation is must to bring about reduction in immobility and decreased functional independence. The comprehensive stroke rehabilitation programs with sufficient resources, dose, and duration is an essential component of stroke care and should be a prime focus in these reformative agenda.

4. **Kamalakannan et al 2017 study,** says that the values of incidence and prevanlence of stroke were higher than the developed countries. The burden of stroke in India is much more higher than what we thought of. A good-quality studies on epidemiology will help us to prevent against stroke as well as better rehabilitation be delivered in countries like India.

5. **Lindley et al 2017 study,** says that organized rehabilitation services are inaccessible to many Indians living with stroke. Family-led stroke rehabilitation continued at home is not an alternate solution to low resource setting like India, whereas the future research should be to investigate the outcome of home program shifting to health-care assistants or team-based community care.

Literature review on mirror neuron

6. **Decety et al 1999** says that the bedrock of the human social life is our ability to generate actions and to recognize actions performed by others. Neurophysiological evidence suggests that the processes underlying perception and action sharing a common representational framework. Same neural code is the fundamental, that is, observers understand the actions of another individual that they use to produce the same actions outwardly.

7. **Rizzolatti et al 2004** says that stimulation formed by action done by others is an important survival tool for primates, particularly humans. Social is not at all possible without action understanding. The properties of human mirror-neuron system is reviewed to explain the humans capacity to learn through imitation.

8. **Small et al 2012** says that in this paper an experimental evidence on the role of the mirror neuron system in action understanding and imitation, in hand motor function is reviewed. Based on mirror neuron system and its role in motor learning, this paper discussed the use of action observation and imitation as an approach for systematic training in the upper limb rehabilitation of patients with motor impairment following stroke.

9. **Sale et al 2012** says that In humans, the mirror mechanism is also located in various brain segment: It is therefore believed that this multi-sensory action-observation system enables individuals to (re) learn impaired motor functions through the activation of these internal action-related representations.

10. **Small et al 2013** says that the action observation treatment, which aims to enhance brain network connectivity. Brain plasticity is a synaptic phenomenon that is largely stimulus-dependent, and that brain repair required both physical and behavioural interventions that are tailored to reorganize specific brain circuits.

11. **Carvalho et al 2013** says that the studies showed how the interaction among vision, proprioception and motor commands promotes the recruitment of mirror neurons, thus providing cortical reorganization and functional recovery of post-stroke patients. We conclude that the experimental advances on Mirror Neurons will bring new rational therapeutic approaches to post-stroke rehabilitation.

12. **Ferrari et al 2014** says that the first discovery about mirror neurons is published in the year 1992. The mirror neurons are basically motor neurons. The evidence has been mounting to prove the presence of mirror neurons in humans. The first-person action understanding is similar to 'your movement is my movement'. Mirror mechanism is extremely useful for practical application in neurological disorders.

13. **Oouchida et al 2014** says that the study of mirror neuron mechanism has changed the concept of motro control in neuroscience. It unifies the motor and sensory aspects of motor control in rehabilitation, learning through imitation. The clinical application of movement rehabilitation from motor impairement after brain damage is introduced in this paper.

14. **Inui et al 2014** says that the properties of human mirror neuron system (MNS) is revealed by using noninvasive imaging techniques (magnetic resonance imaging (MRI), positron emission tomography (PET), and noninvasive brain stimulation such as transcranial magnetic stimulation (TMS) or electrical stimulation).

15. **Cook et al 2014** says that mirror neurons originate in sensorimotor associative learning. There is now evidence that mirror neurons are also present in the human brain. Many mirror neurons fire not only when the animal is performing an action, such as grasping an object using a power grip, but also when the animal passively observes a similar action performed by another agent. By sensorimotor training the mirror neurons can be changed in many ways.

16. **Murata et al 2014** says that many studies have emphasized intrinsic simulation as a core concept for mirror neurons. Much knowledge about the relationship between social cognitive function and the motor control system has been accumulated through mirror neuron discovery.

17. **Brunner et al 2014** says that plastic changes in neurons responding to action observation and action execution occurred in accordance with clinical recovery. The involvement of motor areas when observing actions early and later after stroke may constitute a possible access to the motor system.

18. **Salles et al 2015** says that Regarding the movement organization, it is possible to yield a relevant impact through the understanding of actions and intentions of others, which is mediated by the activation of mirror-neuron systems. The implementation of cognitive functions (observation, image of the action and imitation) from the acute treatment phase allows the activation of motor representations without having to perform the action and it plays an important role in learning motor patterns.

Literature review on mirror therapy

19. **Michielsen et al 2011** concludes that the randomized controlled trial had shown some effectiveness for mirror therapy in chronic stroke patients with moderate upper extremity hemiplegia and is also shown to be associated with cortical reorganization. Future research is needed to determine the optimum practice intensity and duration for maintaining the improvement.

20. **Rothgangel et al 2011** says that there is a moderate quality of evidence that MT as an additional intervention improves recovery of arm function. Firm conclusions could not be drawn. Little is known about which patients are likely to benefit most from MT, and how MT

should preferably be applied. Future studies with clear descriptions of intervention protocols should focus on standardized outcome measures.

21. **Kang et al 2011** concludes that in both groups, corticospinal excitability was facilitated by viewing the mirror image of the activity of the ipsilateral hand. These findings provide neurophysiological evidence supporting the application of various mirror imagery programs during stroke rehabilitation.

22. **Thieme et al 2012** concludes that the results indicate evidence for the effectiveness of mirror therapy for improving upper extremity motor function, activities of daily living and pain, at least as an adjunct to normal rehabilitation for patients after stroke. Limitations are due to small sample sizes of most included studies, control interventions that are not used routinely in stroke rehabilitation and some methodological limitations of the studies.

23. **Manuscript et al 2012** concludes that this study showed no effect on sensorimotor function of the arm, activities of daily living and quality of life of mirror therapy compared to a control intervention after stroke. However, a positive effect on visuospatial neglect was indicated.

24. **Wang et al 2013** concludes that the lateralized cerebral activations are elicited by inversion of visual feedback (movement mirroring), but not by movement observation.

25. **DeAlmeidaOliveira et al 2014** concludes that the mirror therapy and motor imagery protocol was effective for improving motor, sensory, and mobility aspects, as well as function involved in activities of daily living. Qualitative changes in symmetry and muscle co-contraction were found, indicating a possible improvement in upper limb rehabilitation of patients with stroke.

26. **Arya et al 2015** concludes that this pilot trial confirmed the role of task based mirror therapy (TBMT) in improving the wrist–hand motor recovery in post- stroke hemiparesis. Mirror therapy (MT) using tasks may be used as an adjunct in stroke rehabilitation.

27. **Thara et al 2015** that the present study concludes that 10 weeks of task specific motor imagery with mental practice and task specific mirror therapy both shown significant effect on improvement of upper extremity function. However, greater percentage of improvement was found using task specific motor imagery with mental practice in hand function when compared to task specific mirror therapy.

28. **Arya et al 2017** concludes that in post-stroke hemiparesis, mirror therapy (MT) also led to the improvement in dexterity, coordination, and strength of the less-affected side. In addition to the affected side, the technique may augment the subtle motor deficits of the less-affected side.

29. **Zeng et al 2018** concludes that although the included studies had high heterogeneity, meta-analysis provided some evidence that mirror therapy may significantly improve motor function of the upper limb in patients with stroke. Further well-designed studies are needed.

30. **Pollock et al 2014** concludes that the moderate-quality evidence showed a beneficial effect of constraint-inducedmovement therapy (CIMT),mental practice,mirror therapy, interventions for sensory impairment, virtual reality and a relatively high dose of repetitive task practice, suggesting that these may be effective interventions.

Literature review on motor imagery

31. **Schuster et al 2011** concludes that motor imagery training sessions (MITS) elements of successful interventions were individual, supervised and non-directed sessions, added after physical practice. Successful design characteristics were dominant in the Psychology literature, in interventions focusing on motor and strength-related tasks, in interventions with participants aged 20 to 29 years old, and in MI interventions including participants of both genders.

32. **Barclay-Goddard et al 2011** concludes that there is limited evidence to suggest that MP in combination with other rehabilitation treatment appears to be beneficial in improving upper extremity function after stroke, as compared with other rehabilitation treatment without MP. Evidence regarding improvement in motor recovery and quality of movement is less clear. There is no clear pattern regarding the ideal dosage of MP required to improve outcomes. Further studies are required to evaluate the effect of MP on time post stroke, volume of MP that is required to affect the outcomes and whether improvement is maintained long-term. Numerous large ongoing studies will soon improve the evidence base.

33. **Ietswaart et al 2011** concludes that mental practice with motor imagery does not enhance motor recovery in patients early post-stroke. In light of the evidence, it remains to be seen whether mental practice with motor imagery is a valid rehabilitation technique in its own right.

34. **Schuster et al 2012** concludes that the results will determine whether embedded motor imagery (MI) is superior to added motor imagery (MI). Findings of the semi- structured interviews will help to integrate patient's expectations of MI interventions in the design of research studies to improve practical applicability using MI as an adjunct therapy technique.

35. **Hong et al 2012** concludes that mental imagery training combined with electromyogram-triggered electric stimulation improved motor function of the paretic extremity in patients with chronic stroke. The intervention increased metabolism in the contralesional motor–sensory cortex.

36. **Sharma et al 2013** concludes that in addition to networks specific to each task indicating a degree of independence, we formally demonstrate here for the first time that motor imagery (MI) and executed movement (EM) share cortical networks. This significantly strengthens the rationale for using MI to access the motor networks, but the results also highlight important differences.

37. **Braun et al 2013** concludes that mental practice might have positive effects on performance of activities in patients with neurological diseases, but this review reports less positive results than earlier published ones. Strengths and limitations of past studies are pointed out. Methodologic recommendations for future studies are given.

38. **Mokienko et al 2013** says that the mechanisms underlying the process of motor imagery are similar to the motor control mechanisms It can be used for motor learning in patients with movement disorders. Motor imagery may be the only one method for recovery of motor function in patients with severe paresis.

39. **Kho et al 2014** concludes that Review of the literature revealed a trend in support of the use of motor imagery for upper extremity motor rehabilitation after stroke. Mental imagery could be a viable intervention for stroke patients given its benefits of being safe, cost-effective and rendering multiple and unlimited practice opportunities.

40. **Avanzino et al 2015** concludes that we demonstrated that MI practice lead to the development of neuroplasticity which induced plasticity in M1. These results, expanding the current knowledge on how MI training shapes M1 plasticity, might have a potential impact in rehabilitation.

41. **GarciaCarrasco et al 2016** concludes that mental practice (MP) is effective when used in conjunction with conventional physical therapy for functional rehabilitation of both upper and lower limbs, as well as for the recovery of daily activities and skills.

42. **Tong et al 2017** says that this article briefly reviews the concepts and neural correlates of MI in order to promote improved understanding, as well as to enhance the clinical utility of MI-based rehabilitation regimens. We specifically highlight the role of the cerebellum and basal ganglia, premotor, supplementary motor, and prefrontal areas, primary motor cortex, and parietal cortex.

Literature review on ARAT (Action Research Arm Test)

43. **Michelle McDonnell 2008** says that Reliability and validity: Inter-rater and retest reliability have been shown to be high (ICC > 0.98) in studies involving patients with stroke.

44. **VanWegen et al 2010** concludes that the present study showed good clinimetric properties for both assessments. The high concurrent validity suggests that ARAT and WMFT have significant overlap with regard to the underlying construct that is being measured.

45. **Nordin et al 2014** concludes that the ARAT is a highly reliable observational rating scale at the item level after stroke. Awareness regarding the small systematic disagreements demonstrated in some items is, however, recommended when using ARAT.

METHODOLOGY

STUDY DESIGN

An experimental study design

STUDY TYPE

Comparative study with two groups

Group A: Functional activity based motor imagery with mental practice

Group B: Functional activity based mirror therapy

STUDY SIZE

Total 30 subjects (n-30)

Each group 15 subjects

SAMPLING METHOD

Simple random sampling method, subjects randomly allocated into two groups

SETTING

Home care based rehabilitation

STUDY DURATION

Total 7 weeks

3 days in a week

60 minutes duration

MATERIALS USED

Mirror

Video displayed on the laptop screen

Tea cup with handle

Book

Mobile phone and

Pen

SUBJECT SELECTION CRITERIA

Inclusion criteria:

First-time unilateral hemiplegic stroke right or left

Subjects with hemiplegia between 2 to 6 months post stroke

Ischemic stroke

Age above 40 years and below 80 years

Both male and female subjects

Brunstrom stage of motor recovery of 3 to 5

Modified Ashworth scale score < 2

Exclusion criteria:

Subjects with wrist and finger contracture

Significant visual and auditory impairment

Chronic stroke

Subjects with behavioral and attention impairments

Global aphasia with cognitive impairments

Subjects who were undergoing physical therapy

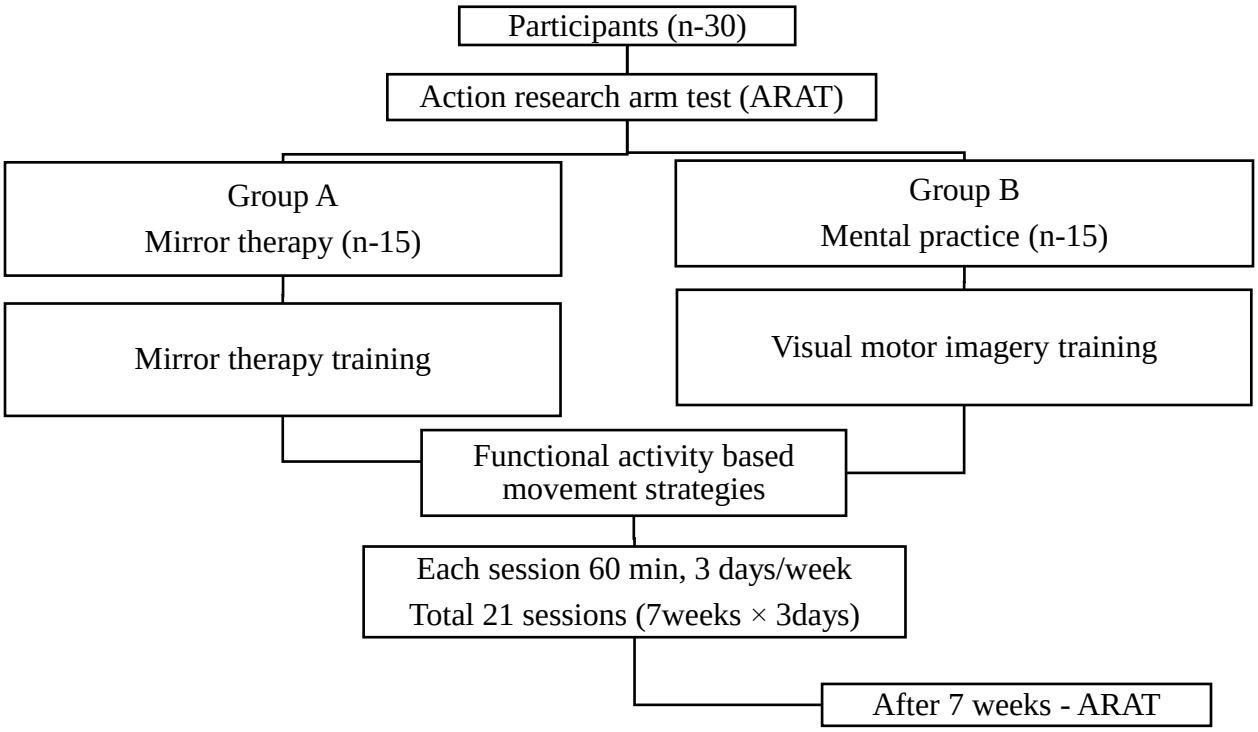
MEASUREMENT TOOLS

Pre and post intervention measurement was done by ARAT scale which evaluates the upper extremity function. Action research arm test (ARAT) was done before and after 7 weeks.

ARAT is used to evaluate upper extremity motor function using 19 tests across 4 subsets: grasp, grip, pinch and gross movement of the hand both proximally and distally. The test took approximately 10 min to administer. Baseline to complete the task was 1 min. The total score is 57.

ARAT is a highly reliable observational rating scale after stroke (Nordin Å et al 2014). This is a standardized format test used to evaluate upper extremity motor function. On the table, test materials were placed and the subjects were seated on a chair comfortably so the subjects could reach and grasp the materials has demonstrated. The failure of doing first and second task by the subject scored has zero, no other subtests needed to be tested. If the subject does the test, he or she needed to complete all tasks within the subtest. When the first task was done by the subject, then no more tasks were needed to be administered and scored top marks. The ARAT scale indicating very high inter-rater reliability and validity (Hsieh CL et al 1998).

PROCEDURE



TRAINING PROTOCOL

- Period : 7 weeks intervention
- Session : 3 days/week (Total 21 sessions)
- Duration : 60 min/day
- Training task : 5 real life rehearsal strategies
- Demonstration & supervision : Physiotherapist
- Environment : Clinical setting & home based
- Outcome measurement : Action research arm test (ARAT)

TRAINING PROGRAM

Interventional procedure for Group A:

In Group A, subjects were treated with functional activity based motor imagery with mental practice inducting physical practice with video previewed consisting of 5 tasks for the duration of 60 minutes for 3 days a week for 7 weeks.

The subject was made to sit on a chair in front of the table containing task related materials like video displayed on the laptop screen, tea cup with handle, book, mobile phone, and pen. The unaffected limb and affected limb was placed on the table. The subject was first asked to observe the video previewed of motor tasks. Then the subject was asked to mentally practice each activity ten times. Then the instruction to physically practice each activity for ten times was given to the subject. The total duration of motor imagery tasks was for 60 minutes per session. The motor tasks given were, picking up tea cup with handle and taking it to the mouth, and then returning the cup to its initial position, turning pages of a book, reaching the top of the head to comb, picking up a mobile phone to receive the call and holding of a pen to write.

Interventional procedure for Group B:

In Group B, subjects were treated with functional activity based mirror therapy consisting of 5 tasks for the duration of 60 minutes for 3 days a week for 7 weeks.

The subject was made to sit on a table with the mirror stationed between the affected and unaffected limbs. The limb which is affected was placed behind the mirror and the unaffected limb is placed in front of the mirror. The mirror was positioned in front of the subject's midline. The reflection of the unaffected limb was fully visible in the mirror as well the affected limb was fully covered by the mirror. The subject was demonstrated to observe the mirror reflection of the unaffected limb for one to two minutes, trying to visualize and perceive the mirror image as the affected limb. Once the subject perception with the mirrored limb got engaged they were asked to perform motor activities slowly, easy to achieve mentally perceived bilateral movements by looking at the reflected image. The functional activity based motor tasks were, picking up tea cup with handle and taking it to the mouth, and then returning the cup to its initial position, turning pages of a book, reaching the top of the head to comb, picking up a mobile phone to receive a call and holding of a pen to write.

Subjects were instructed to do home exercise program for the rest of the days in a week and were demonstrated about the functional activity exercises and were practiced at home. Twice a day home program was done and recorded in a log note. All exercises were real life functional activity for both the upper extremity and lower extremity.

Figure 1: Functional activity based motor imagery training with mental practice

a. 

b. 

c. 

d. 

e. 

f. 

Figure 2: Functional activity based mirror therapy training

a.  b.  c. 

d.  e.  f. 

Figure 1 & 2: a.) Holding a tea cup and taking it to the mouth, b.) Reaching the top of head to comb, c.) Turning the pages of the book, d.) Holding the pen to write, e.) Reaching the mobile to pick up a call, f.) Previewing the video / perceiving it has affected limb

STATISTICAL METHODS

Descriptive statistical analysis method was presented in this study. The subsets of ARAT and the total value of ARAT is presented and analyzed as mean ± SD. The significant level of the study was set at p-value 0.05, less than this is considered as the statistically significant difference. Inter group analysis is carried out to compare the values of variables between two groups using Independent‘t’ test as a parametric. The Statistics were done using MS Excel 2013 Data analysis. The Microsoft Word and Excel have been used to generate graphs, tables etc.

RESULTS

Total 30 subjects participated in the study. Group A there were 15 subjects with 10 males and 5 females were participated in the study. In Group B there were 15 subjects with 9 males and 6 females were participated in the study. No significant difference was found in mean age, duration and Brunstrom stage between the two groups.

When means of Action Research Arm Test were analyzed there was a significant change between Group A and Group B. The means of the total score of ARAT were showing significant changes from pre-intervention to post-intervention analysis. This shows there is a clinically significant improvement between the two groups.

There was no statistically significant difference when pre-intervention means of grasp, grip, pinch, gross movement of ARAT were analyzed between group A and group B. This shows no clinically significant difference among the groups who had Action Research Arm Test as a baseline measurement before 7 weeks of intervention.

After 7 weeks of post-intervention, means of Action Research Arm Test – grasp, grip, pinch, Gross Movement, and total Score were compared and analyzed for the statistical difference. There found to have no statistically significant differences in grasp, grip and pinch score between group A and group B, but there was a statistical difference in gross movement score between group A and group B. This shows a marked difference clinically in moderate effect size.

Table1:Comparison of means of Action Research Arm Test between Group A and Group B

(Pre-intervention Comparison)

Pre-intervention	Group A (Mean ± SD)	Group B (Mean ± SD)	t value (Parametric)	Significance P value
ARAT-grasp	13 ± 2	12.6 ± 1.76	0.580	P = 0.566 (NS)
ARAT-Grip	5.13 ± 2.09	4.6 ± 1.68	0.767	P = 0.449 (NS)
ARAT-Pinch	5.2 ± 1.78	5.06 ± 1.22	0.239	P = 0.813 (NS)
ARAT-Gross Movement	2.26 ± 0.88	2.2 ± 0.77	0.219	P = 0.827 (NS)
ARAT-Total	25.6 ± 3.77	24.46 ± 2.23	1.000	P = 0.327 (NS)

NS – Not significant; t value – independent t test

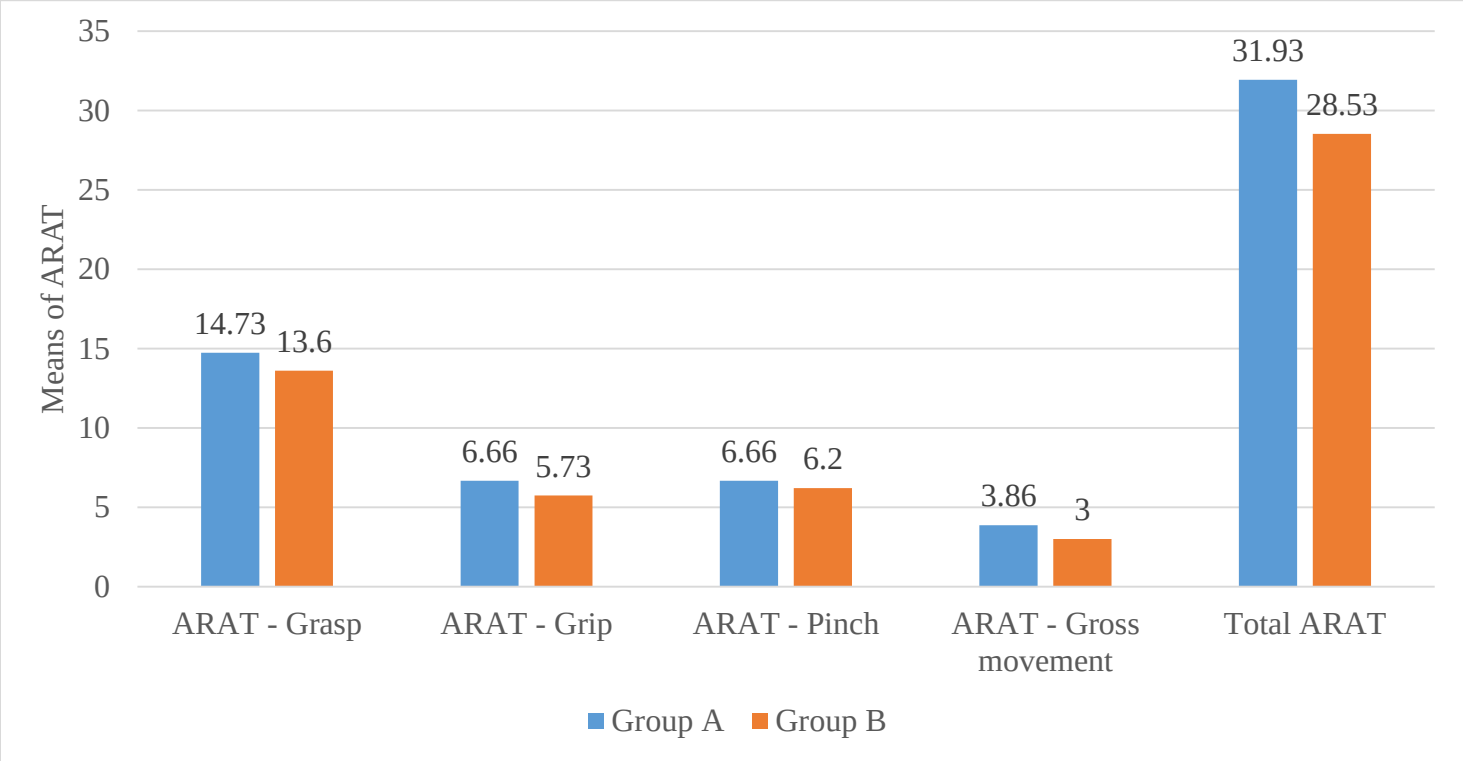
Table2:Comparison of means of Action Research Arm Test between Group A and Group B

(Post-intervention comparison)

Post-intervention	Group A (Mean ± SD)	Group B (Mean ± SD)	t value (Parametric)	Significance P value
ARAT-grasp	14.73 ± 1.90	13.6 ± 1.72	1.707	P= 0.098
ARAT-Grip	6.66 ± 1.91	5.73 ± 1.75	1.393	P = 0.174
ARAT-Pinch	6.66 ± 1.98	6.2 ± 0.65	0.787	P = 0.439
ARAT-Gross Movement	3.86 ± 1.06	3 ± 0.65	2.694	P = 0.012 **
ARAT-Total	31.93 ± 3.97	28.53 ± 2.41	2.832	P = 0.009 **

** Statistically significant $p < 0.05$; t value – independent t test

Graph 1: Post intervention comparative analysis of means of ARAT between Group A and Group B



The graph which above shows a compared analyzes of post-intervention mean values of Action Research Arm Test scores of grasp, grip, pinch, Gross Movement individually depicted. The total score of ARAT and gross movement score shows a significant difference and there is no significant difference in grasp, grip and pinch scores.

DISCUSSION

The findings from the present study revealed that there is statistically as well as clinically significant improvement in hand motor functions in subjects who received 7 weeks of functional activity based motor imagery training with mental practice than the subjects who underwent functional activity based mirror therapy training.

Brain science had underpinned the close functional similarities in neural connections for motor planning and motor execution (M. Jeannerod 1994). Is the actions done by other individuals provoke a same neural correlation in the brain was the subject of research for brain enthusiast. Our culture is based on learning which is called as imitation learning for the social being to survive. Research has explored the neurophysiological mechanism on the mirror-neuron mechanism which fascinates the science community on action perception and action understanding by humans (Rizzolatti G et al 2004)

Motor imagery or the mental practice is a dynamic state in which representation of given motor act is internally rehearsed in the mind without any physical motor output. There is a connection between the basal ganglia and the prefrontal cortex to maintain a dynamic motor output. (Decety J 1996). The scientific reason behind the significant change in mental practice (MP) group is associated with the activation of this neural networks in planning and execution of movements. Though there is no muscular activity the mental practice (MP) can stimulate and process information in neurons which in turn induces neuroplasticity. Motor imagery can be divided into kinesthetic motor imagery and visual motor imagery. The kinesthetic is the first person perspective whereas the visual imagery is seeing others action (Neuper C et al 2005).

In this study visual motor imagery was applied through a video which was previewed to the subject, then the subject has to simulate the same movement in a real-world scenario. Motor learning can be guided by proprioceptive techniques, tactile stimulation, and vestibular, visual and auditory information (Thara N et al 2015).

There is a solid evidence showing motor imagery activates similar cerebral neurons like those happening during actual physical movements (Guillot A et al 2009). So it is a top-down neuro technique where the neurons get activated just by observing others actions or movements where it enhances neuroplasticity and learning of complex motor tasks in a simple methodology. The

role of primary motor areas in movement imagery is discovered in a research measuring electrocortical activity (Kai J. Miller et al 2010). Hence in this study, functional activity based motor imagery with mental practice is found to be an effective therapy to improve motor functions of the upper limb in a home-based environment itself i.e. self-administered.

In a recently published stroke journal, guidelines has been issued to deliver a evidence-based neurorehabilitation and recovery for the stroke patients. For the upper limb exercise therapy mental practice (MP) is an adjunct tool. Mental practice (MP) is recommended in a class 2a with level of evidence A (Winstein CJ et al 2016).

Functional activity based mirror therapy training too is clinically beneficial to improve an upper limb motor function. It's a very simple and promising neuro intervention where it illusion the brain to subtly activates a neuron which are not used due to weakness. The sensorimotor activation due to the mirrored image of the unaffected limb favor to overcome the compromised hemisphere due to the neglect of one side of the body. A recently published meta-analysis study has given credit to mirror therapy in improving motor function of the upper limb in patients with stroke (Zeng W et al 2018). Mirror therapy with functional activity or the task-oriented activity may augment and improve the muscle strength of the upper limb (Arya KN et al 2017. The mirror therapy increases corticospinal excitability of the neurons that are stimulated during normal movements than directly visualizing a normal hand (Jeonghun Ku et al 2011). The Cochrane review recommended mirror therapy (MT) to improve activities of daily living (ADL) and as an adjunct to conventional rehabilitation (Holm Thieme et al 2012).

Lot more studies have been done on mental practice and mirror therapy in combination with task-oriented activities. In this study functional activity based training strategies had been given to find out the efficacy of the two techniques. The patients who underwent this study didn't get fatigue due to less physical activity during the intervention. Through this study, it has been found that mental practice regimen with the functional activity-based approach is significantly effective in upper limb motor training for the sub-acute hemiplegia. Therefore, the null hypothesis is rejected.

CONCLUSION

The present experimental study concludes that the 7 weeks of functional activity based motor imagery with mental practice and functional activity based mirror therapy both shown a significant effect on improvement of upper extremity function. However, functional activity based motor imagery with mental practice found to be effective in improving hand motor function when compared to functional activity based mirror therapy. To administer a comprehensive neurological rehabilitation program it is important to consider both the treatment techniques for the stroke patients in improving upper limb function to engage them in activities of daily living.

LIMITATIONS OF THE STUDY

1. Ischemic stroke subjects alone was taken up for the present study.
2. Duration of the stroke subjects with 2 to 6 months only was selected.
3. Subjects were not included with the Brunstrom stages of 1 and 2.
4. The number of real-life rehearsal strategies is taken only 5 for the study.
5. ARAT is the only Outcome measurement tool to measure the recovery.

RECOMMENDATION FOR FUTURE RESEARCH

As mentioned in the Cochrane review (Ruth E Barclay-Goddard et al 2011) evidence regarding the movement quality and motor recovery should be studied in in-depth scientific physiotherapeutic approach. The ideal dosage to administer mental practice (MP) intervention should be made clear by recruiting a large population. More functional activity based training should be embedded in research along with mental practice and mirror therapy. A tool to find out motor imagery activity should be used in research to confirm the cognitive rehearsal. How far the improvement is well able to be preserved in a aftermath of intervention is to be ascertained by doing a follow-up or prospective kind of study.

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APPENDIX 1

INFORMED CONSENT LETTER

CONSENT FORM

This is to certify that I _____ aged _____ freely and voluntarily agreed to participate in the study **EFFECTIVENESS OF MOTOR IMAGERY VERSUS MIRROR THERAPY TO IMPROVE UPPER LIMB TRAINING IN STROKE SUBJECTS – A COMPARATIVE STUDY.** The observer had explained about the procedures and the benefits and risk that would occur during the study. All information given by me will be kept strictly confidential and used for research purpose.

PLACE:

DATE:

PARTICIPANT SIGNATURE

APPENDIX 2

ACTION RESEARCH ARM TEST

Grasp subscale		
1. Block, wood, 10 cm cube	0 1 2 3	
2. Block, wood, 2.5 cm cube	0 1 2 3	
3. Block, wood, 5 cm cube	0 1 2 3	
4. Block, wood, 7.5 cm cube	0 1 2 3	
5. Ball (Cricket), 7.5 cm diameter	0 1 2 3	
6. Stone 10 x 2.5 x 1 cm	0 1 2 3	
	Subtotal	___ /18
Grip subscale		
7. Pour water from glass to glass	0 1 2 3	
8. Tube 2.25 cm	0 1 2 3	
9. Tube 1 x 16 cm	0 1 2 3	
10. Washer (3.5 cm diameter) over bolt	0 1 2 3	
	Subtotal	___ /12
Pinch subscale		
11. Ball bearing, 6 mm, 3rd finger and thumb	0 1 2 3	
12. Marble, 1.5 cm, index finger and thumb	0 1 2 3	
13. Ball bearing 2nd finger and thumb	0 1 2 3	
14. Ball bearing 1st finger and thumb	0 1 2 3	
15. Marble 3rd finger and thumb	0 1 2 3	
16. Marble 2nd finger and thumb	0 1 2 3	
	Subtotal	___ /18
Gross movement subscale	0 1 2 3	
17. Place hand behind head	0 1 2 3	
18. Place hand on top of head	0 1 2 3	
19. Hand to mouth	0 1 2 3	
	Subtotal	___ /9
	TOTAL	___ /57

APPENDIX 3

The Seven Brunnstrom Stages of Motor Recovery

STAGES	CHARACTERISTICS
1.	Flaccid paralysis. No reflexes.
2.	Some spastic tone. No voluntary movement. Synergies elicited through facilitation.
3.	Spasticity is marked. Synergistic movements may be elicited voluntarily.
4.	Spasticity decreases. Synergistic movements predominate.
5.	Spasticity wanes. Can move out of synergies although synergies still present.
6.	Coordination and movement patterns near normal. Trouble with more rapid complex movements.
7.	Normal.

APPENDIX 4

MODIFIED ASHWORTH SCALE

SCORING

0	Normal tone, no increase in tone
1	Slight increase in muscle tone, manifested by a catch and release or minimal resistance at the end of the range of motion (ROM) when the affected parts is moved in flexion or extension.
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone through most of the ROM, but affected parts easily moved.
3	Considerable increase in muscle tone, passive movement difficult
4	Affected parts rigid in flexion or extension

MASTER CHART

S.NO	AGE	GENDER	TSS	BRUNNSTROM	MAS	ARAT	
1.	71	M	4	3	1	24	28
2.	49	M	2	5	1+	23	30
3.	53	F	6	3	1	28	35
4.	67	M	5	5	1+	19	27
5.	69	M	3	4	1	30	39
6.	73	M	2	4	1	22	32
7.	60	F	4	5	1+	28	36
8.	58	M	5	3	1	29	35
9.	55	M	6	3	1+	26	31
10.	67	F	2	4	1+	22	26
11.	74	M	2	5	1+	25	30
12.	78	M	5	4	1+	31	37
13.	58	F	4	5	1	28	33
14.	54	M	3	3	1+	29	33
15.	73	F	5	4	1	20	27
16.	68	M	3	5	1	25	29
17.	60	M	3	3	1+	27	29
18.	76	F	2	4	1+	22	26
19.	57	F	5	3	1	23	28
20.	62	M	6	4	1+	26	30
21.	77	M	3	5	1	28	34
22.	59	M	4	3	1	26	32
23.	64	F	5	4	1+	23	28
24.	72	M	6	3	1+	24	29
25.	79	M	4	4	1+	23	29
26.	53	F	4	5	1	27	29
27.	68	M	5	4	1+	22	26
28.	74	F	2	3	1+	21	24
29.	71	M	2	5	1+	27	28
30.	66	F	4	3	1	23	27

TSS: Time since stroke, MAS: Brunnstrom scale, Modified Ashworth Scale